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Editorial

ANIMAL HUSBANDRY AND THE WAR

AGRICULTURE is a most essential industry during times of peace in this or in any other country. In time of war an efficient agricultural service is absolutely vital to the life of a nation. These two facts are well known to everyone and yet it is a strange fact that throughout the long history of our land it has been only in times of great stress that the industry has been recognised at its true value. We are a complacent people, for we have not only neglected the opportunities displayed at home, but we have not made full use of all resources of a great Empire. It is an extraordinary circumstance that a large percentage of the agricultural food products which are in daily use in this country should have their origin in foreign lands when we have at hand and within the bounds of the Empire facilities to supply all our needs. Many were of the opinion that the lessons of the Great War would not be forgotten so readily, but forgotten apparently they have been and it has taken another international crisis to arouse public opinion again. Agriculture and its products may be divided into two great categories, Arable and Animal Husbandry. As regards arable husbandry, there is no doubt that we could supply all needs other than those of the cereals. It is a debatable point if it is good policy to try to grow great quantities of wheat and oats, etc., when the land here could be put to a more profitable use and also for the good reason that cereals can be produced in

abundance in the Dominions and Colonies and they can be stored with ease. As regards animal husbandry, and in this we include all varieties of stock, no such doubts arise. This land is blessed above all others in the quality of the stock which it produces. Our animals are supreme, so much so that the rest of the world looks to us when it wants to replenish or increase the quality of its stock. If the animal husbandry industry of Britain was efficiently organised and reasonably encouraged all our wants in this direction could be supplied. There would be no need to import those stupendous quantities of meat, eggs, butter, cheese, etc., which are a daily feature of life at our ports. Some may say that it is a question of the cost to the consumer, but such is not the case. There is not a sufficient disparity in cost between the foreign and home-grown products. If production in this country was stimulated, constantly and not spasmodically, there is no doubt that the resulting efficiency and the consequent increase of output would lower production costs considerably. To attain this end three factors must be brought to bear. The public must be encouraged to specify the home-produced article, the Government must stimulate by financial and other aids, and the veterinary profession must play its part. The farming community looks to the veterinary surgeons to help them in the realms of animal husbandry. Advice will be sought on the problems associated with breeding, rearing and feeding, and the utilisation of animal products. In these matters there should be no greater authority than the veterinary surgeon. Disease and its control and elimination will also present its problems. There is no doubt that in the latter sphere the veterinary profession has proved its worth in the past. At the present time it is in the realms of what might be called pure animal husbandry that we may pull our weight to the best advantage.

Parliament has recognised that the veterinary surgeon is a key man in the economic system and his profession has been made a reserved occupation. The good agriculturalist has always tried to make two blades of grass grow where one grew previously. Let us as veterinary surgeons endeavour to use our knowledge so that we may carry this thought a step further and enable the farmer to increase the production of his stock at least twofold. Much is expected; we must not fail.

General Articles

PUSTULAR ACNE IN THE HORSE

By HARRY LOMAS, M.R.C.V.S.
London.

THIS insidious affection of the skin is characterised by the occurrence of small abscesses in groups or clusters with the special peculiarity that they are always situated on an area which is in the site of harness: the skin over the nasal bones, the withers and shoulders, the back and croup, corresponding respectively with the nose-bag, nose-band of the bridle, collar, pad, and crupper.

The abscesses are very small, superficial, for the most part about the size of a split pea, and are devoid of hair when truly ripe. But they are rather slow in maturing from the papular stage, and the thicker the skin the slower the process.

This feature appears to apply all the way through the course of the affection—in incidence, duration and treatment, whether the latter is by chemical means or by vaccine; and it looks very odd indeed to see the disease cured over the nasal region whilst still going on in the same horse in another area in which the skin is thicker.

The siting of the areas — always under harness — was in itself almost sufficient to convince one that a microbe should be the cause; and, further, when really reliable antiseptics were used over the affected areas and still the abscesses appeared in almost daily succession one could only assume that they were simply crops that could be caused by two agencies—the grooming tools going over them every day, and the little movements of the harness during work.

It is a small matter to open the abscesses, but the cost of keeping in the stable during treatment and the loss of service owing to the long time these cases take are quite a consideration. Further, one has to bear in mind the fact of recurrences, for there have been such happenings after the patients had been discharged for work, despite the regular attention they had previously received. Hence the reasoning that a vaccine might be usefully employed. A swab was sent to a bacteriologist with this object in mind, and in due course the report stated that it was a pure culture of a staphylococcus, and so a vaccine was prepared.

The dose is one c.c. and, in all, three doses are given, each at an interval of six days under the skin of the breast, the usual aseptic precautions being taken.

XUM

The vaccine can be used not only on the horse, from which it was originally derived, but also on any other such cases until the supply is exhausted. When this occurs, one obtains a supply of vaccine from the next case that arises.

This method of treatment, along with the opening of abscesses and the use of antiseptics locally, has been in use for about fourteen years.

The results are very good in one respect—there are no recurrences, but it could not be noticed that it appreciably reduced the time lost during treatment.

They behave in this manner: a case affected on the thin skin of the nose would require about five or six weeks; on the shoulders, about seven weeks; but if on the back or croup where the skin is very thick, about ten.

It is perhaps reasonable to infer that vascularity plays a very important part in the variations of the periods of time in the curing process and one particularly notes the early recovery on the nasal region as compared with other areas.

Preventive measures are always of value and there is nothing better than the blow-lamp for disinfecting stalls and boxes. The harness and grooming tools (rubbers should be burnt) can be satisfactorily dealt with by cleansing them thoroughly with plain soft soap and water, but any woollen lining should be removed. Then all smooth fabric linings and the leather are swabbed with formaldehyde 40 per cent.—one ounce in one gallon of water.

This chemical does no harm to leather or smooth fabric linings at this strength.

I am indebted to Dr. Mitchell, of Messrs. Evans Sons, Lescher and Webb, and to Dr. Minett, of the Royal Veterinary College, for their help and collaboration.

THE PARTITION OF SERUM CALCIUM IN DOMESTIC ANIMALS — SOME PATHOLOGICAL CASES

By J. DUCKWORTH and W. GODDEN
The Rowett Institute, Aberdeen.

It is doubtful whether clinical chemical analysis of blood samples will ever be as widely used in veterinary as in human medical practice. On the other hand, it is generally more easy to pursue an investigation of an animal disease than a human disease and large amounts of data can be more readily accumulated. The great advantage of being able to compare such results with those obtained in rigidly controlled animal experiments on the same species is peculiar to veterinary pathology.

We have been carrying out long-term investigations of the influences of

various factors on the partition of serum calcium in cows and sheep. During the course of these studies, pathological samples were occasionally available and were examined according to our standard technique. As far as we know, there are no similar studies on record and it seems worth while to present these cases now so that the data are available to those more closely connected with pathological problems.

The value of estimating total serum calcium for diagnostic and therapeutic purposes is well established, but the gross determination of a constituent composed of several chemically distinct fractions may have limited value in physiological and pathological investigations. This has, of course, been realised for many years and, in the case of serum calcium, the primary separation into the ultrafiltrable and non-ultrafiltrable forms has been widely studied. From the data on record it seems that about 60 per cent. of the calcium of serum is ultrafiltrable, or diffusible, in most species of animals, although our studies have shown that only about 50 per cent. is ultrafiltrable in dairy cows. Evidence to the contrary being absent, it is generally assumed that the ultrafiltrable fraction of serum calcium is physiologically active and that the non-ultrafiltrable fraction represents, at least in part, a circulatory reserve of calcium which, when conditions arise that depress the level of ultrafiltrable calcium, liberates calcium ions. In passing it might be pointed out that a connection may exist between the normally low level of physiologically active serum calcium in the dairy cow and the susceptibility of this animal to disorders in which hypocalcæmia is an outstanding symptom.

Within the last few years, many attempts have been made to subdivide the ultrafiltrable and non-ultrafiltrable calcium fractions. Benjamin and Hess (1933) showed that the ultrafiltrable calcium exists in two forms: calcium in ionic form and calcium in the form of a complex. This complex was subsequently shown to contain calcium, phosphate and bicarbonate ions (Benjamin, 1933). The non-ultrafiltrable calcium was shown to exist in two forms: a

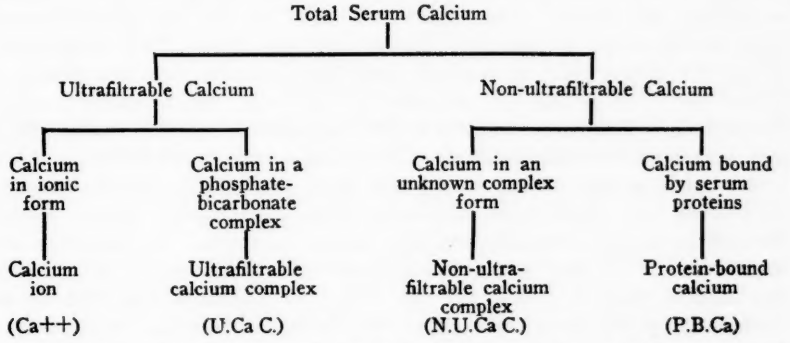

FIG. 1.—Schematic representation of the fractionation of serum calcium.

complex of unknown composition and a (presumably) calcium-serum protein complex. The relation of the different fractions to each other are shown in Fig. 1.

Very little is known of the factors responsible for the equilibrium existing between the different fractions. The degree of ultrafiltrability is, in part, dependent upon plasma pH, but normal and pathological ranges of variations in pH are relatively so narrow that the effects of plasma pH changes can be disregarded as an influence on serum calcium ultrafiltrability. The partition between ultrafiltrable and non-ultrafiltrable forms is, as Rây (1938) has shown, influenced to some extent by the level of serum inorganic phosphorus, but the manner in which this occurs is not clear. The relation of Ca^{++} to U.Ca C. is influenced by the amount of inorganic phosphorus in the serum, as would be expected since the U.Ca C. contains phosphate. The P.B.Ca is in equilibrium with Ca^{++} and, while frequently the relation seems simple and direct, we have occasionally found cases which were somewhat exceptional and, therefore, suggest the existence of other influencing factors. Nothing is known of the nature of the N.U.Ca C. and the factors governing its existence and fluctuations are the least understood. Fundamentally the equilibrium between the four fractions is physico-chemical, but, at present, only some of these factors are recognised.

Evidence is gradually accumulating about the physiological importance of the different calcium fractions. As far as direct physiological action is concerned the two non-ultrafiltrable fractions can probably be disregarded (except, probably, the role of the N.U.Ca C. in rickets). This, however, does not rule out the existence of characteristic changes associated with well-defined pathological conditions. It is generally considered that the Ca^{++} plays an important part in the mechanism of blood coagulation. If this is correct and if the U.Ca C. has no function in the coagulation mechanism, then the amount of Ca^{++} required in the reaction must be small, since we have observed no marked inhibition of coagulation in blood samples where Ca^{++} was as low as 0.3 mg. per 100 ml. The U.Ca C. and the N.U.Ca C. are both removed from normal serum by entirely calcifying cartilage, apparently by adsorption. When the serum level of U.Ca C. and N.U.Ca C. falls to low levels in rickets calcifying cartilage is incapable of adsorbing these complexes, as has been shown by Benjamin and Hess in their experiments where normal cartilage was immersed in rachitic serum. The P.B.Ca appears to have no direct physiological action. It apparently acts as an immediately available reserve of calcium ions. The value of such a defence mechanism against sudden fluctuations in physiologically available calcium is obvious for, otherwise, the organism would depend on the slower process of mobilisation of calcium from the skeletal reserves. Normally the deficit is ultimately remedied by an outflow of calcium from the skeleton but, during the time-lag, the burden of supplying calcium ions is borne by the P.B.Ca.

Analytical Methods

We have presented elsewhere complete details of the technique used (Duckworth and Godden, 1936.)

Results

All values are expressed in milligrams per 100 ml. of serum except serum proteins which are expressed in grams.

CASE 1. COW WITH HOVEN.

Serum	Time 4.50 *a.m.*	6.10 *a.m.*	10.10 *a.m.*
	mg.	mg.	mg.
Inorganic P	1.56	4.44	4.94
Total Ca	4.4	7.2	9.5
Ca^{++}	1.1	1.0	1.2
U.Ca C.	1.1	3.1	3.9
N.U.Ca C.	0.5	1.3	1.8
P.B.Ca	1.7	1.8	2.8
Total Mg.	0.90	1.49	1.91

After the first sample was taken the udder was inflated. At the time of the second sample the stomach was punctured by trochar. By the time of the third sample the animal was almost normal in appearance. Ca^{++} did not change throughout. The main effect of inflation was an increase in the U.Ca C., a change which was associated with the increase in organic P. The P.B. Ca increased independently of the Ca^{++}.

CASE 2. COW WITH RETAINED PLACENTA.

Serum	*Before Inflation*	*After Inflation*
	mg.	mg.
Total Ca	9.8	11.2
Ca^{++}	2.3	2.0
U.Ca C.	3.7	5.2
N.U.Ca C.	1.3	1.2
P.B.Ca	2.5	2.8

The case arose seven days after calving owing to a retention of part of the placenta. The symptoms were similar to those of milk fever but not identical. The effect of inflation was an increase in total serum calcium which was associated with a proportional increase in the U.Ca C.

CASE 3. COW WITH STOMACH STAGGERS.

Serum	*mg.*
Total Ca	7.8
Ca^{++}	1.8
U.Ca C.	2.4
N.U.Ca C.	2.0
P.B.Ca	1.6

In this case the U.Ca C. was well below the normal range. Ca^{++} was somewhat above normal levels and P.B.Ca was below normal levels. N.U.Ca C. was normal.

CASE 4. COW WITH ACETONÆMIA.

Serum	*1st Sample*	*2nd Sample*
	mg.	mg.
Inorganic P	3.62	4.28
Total Ca	11.7	11.5
Ca^{++}	2.0	1.5
U.Ca C.	3.9	4.4
N.U.Ca C.	2.8	2.5
P.B.Ca	3.0	3.1

A three-day interval occurred between the two samplings. At the time of the second sample the cow had recovered. There was no marked deviation from normal in the partition of the serum calcium at either bleeding. The increase noted in the U.Ca C. was probably associated with the increase in serum inorganic P.

CASE 5. CALF WITH CONVULSIONS WHILST ON AN EXCLUSIVELY MILK DIET.

Serum	*Before Treatment*	*After Treatment*
	mg.	mg.
Total Ca	8.6	9.5
Ca^{++}	1.4	1.2
U.Ca C.	3.2	3.9
N.U.Ca C.	1.6	2.1
P.B.Ca	2.4	2.3
Total Mg.	0.74	1.60

The animal was given a subcutaneous injection of magnesium sulphate. There was a 24-hour interval between samples. The main characteristics of the first partition were somewhat depressed levels of the U.Ca C. and the N.U.Ca C. At the second sampling both these complexes had increased in value, the N.U.Ca C. having reached normal levels.

Serum	*Before Supplement*	*After Supplement*
	mg.	mg.
Total Ca	10.6	10.8
Ca^{++}	1.5	1.6
U.Ca C.	4.6	4.4
N.U.Ca C.	2.1	2.7
P.B.Ca	2.4	2.1
Total Mg.	0.94	2.78

After three weeks' interval the calf again showed signs of hypersensitivity although convulsions did not develop. Magnesium carbonate was then added

to the milk daily and the animal became almost normal. There was an interval of one week between samplings.

In so far as concerns serum Ca and its partition, all the figures were within the normal range both before and after supplementary feeding. It may be noted that there was a marked rise in serum Mg. following both the above treatments.

CASE 6. CALF WITH CONVULSIONS WHILST ON AN EXCLUSIVELY MILK DIET.

Serum	*mg.*
Inorganic P	6.76
Total Ca	7.5
Ca^{++}	1.4
U.Ca C.	3.9
N.U.Ca C.	0.1
P.B.Ca	2.1
Total Mg.	0.79

The N.U.Ca C. was markedly below normal, having almost disappeared.

CASE 7. HORSE WITH GRASS SICKNESS.

Serum	*mg.*
Total Ca	13.7
Ca^{++}	2.9
U.Ca C.	6.1
N.U.Ca C.	0.7
P.B.Ca	4.0
	g.
Proteins	6.96

In this case comparison is difficult because we have no data for normal horses. However, the value for N.U.Ca C. is lower than is found for normal animals of any species. A point of great interest is the high degree of ultrafiltrability of the calcium (66 per cent.). This is above normal for other species and is particularly striking in view of the high level of serum proteins. It is generally considered that ultrafiltrability is reduced in cases characterised by high serum protein levels.

CASE 8. SHEEP WITH DROPSY.

Serum	*mg.*
Inorganic P	6.58
Total Ca	11.7
Ca^{++}	1.3
U.Ca C.	5.3
N.U.Ca C.	1.8
P.B.Ca	4.3

In this case the P.B.Ca alone is affected. The value for this constituent is well above normal.

CASES 9 AND 10. TWO SHEEP WITH TETANY.

Serum	*Sheep* 1	*Sheep* 2
	mg.	mg.
Total Ca	3.3	4.3
Ca^{++}	0.3	0.3
U.Ca C.	1.7	1.6
N.U.Ca C.	0.7	2.1
P.B.Ca	0.6	0.3

In these cases the low Ca^{++} values were associated with extremely low values for P.B.Ca. These are good examples of the mobilisation and almost complete exhaustion of this latter fraction in an endeavour to maintain the level of Ca^{++}.

CASES 11, 12 AND 13. SHEEP WITH RICKETS.

Serum	*Sheep* 1	*Sheep* 2	*Sheep* 3
	mg.	mg.	mg.
Total Ca	7.3	7.3	7.0
Ca^{++}	0.7	1.1	0.8
U.Ca C.	3.6	2.7	3.8
N.U.Ca C.	0.5	0.9	0.2
P.B.Ca	2.5	2.6	2.6

These cases are of sheep under continuous observation. The data above are those obtained when the symptoms were most marked. A full description of the blood changes before and after the present data will be published subsequently. As Benjamin and Hess have found in their studies of other species, the U.Ca C. and N.U.Ca C. are both markedly reduced in rickets. We found, however, that the outstanding characteristic was the rapid reduction in N.U.Ca C. at the time of greatest severity of symptoms.

Summary

Data are recorded for the partition of serum calcium in some pathological cases in domestic animals.

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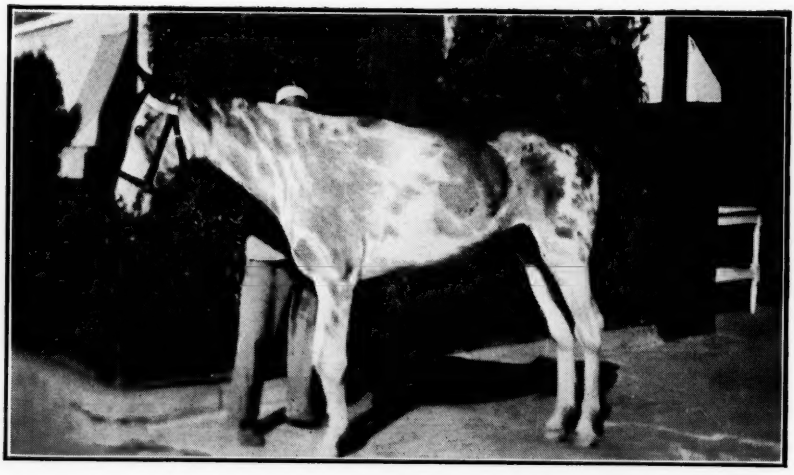

Article by LIEUT.-COL. J. R. HODGKINS, D.S.O., F.R.C.V.S.

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EQUINE ARTICULAR RHEUMATISM

By LIEUT.-COLONEL J. R. HODGKINS, D.S.O., F.R.C.V.S.
The Old War Horse Memorial Hospital, Cairo, Egypt.

In a previous number of this Journal (July, 1939) is an account of a case of equine articular rheumatism. At the time of writing the account, i.e., in November, 1938, the animal was yet alive. Later on, in December, 1938, permission was given for the mare's destruction. The condition just prior to destruction of this Egyptian skewbald mare, age 4½ years, is shown in the accompanying photograph.

Subject: Animal No. 180, articular rheumatism, admitted to hospital August 11, 1938, and destroyed December 28, 1938.

History: On movement she was "hopping" lame of the near hind. There was bursitis of the stifles markedly of the near stifle. Distension of the hock bursæ, *vide* photograph. Condition—very "tucked up." Atrophy of quarter muscles. There was palpitation of the heart on movement. The owner was questioned closely as to the occurrence of any previous grave illness—his reply was in the negative. She was destroyed.

Post-mortem Examination

(1) *The Thorax*—

The lungs and pleura: were quite normal and there was no sign of previous pneumonia or pleurisy.

The heart: except for a few punctate hæmorrhages in the myocardium there was no organic abnormality.

(2) *Abdomen*—

The liver was congested and showed fatty degeneration.

Spleen: nothing unusual.

Kidneys: nothing unusual.

Bladder: nothing unusual.

Uterus: showed the usual retrogressive changes after recent parturition.

Ovaries: very cystic.

(3) *Articulations*—

Stifles: the tissue surrounding the joint was infiltrated and yellow. The synovia very plentiful and of a deep yellow colour. The cartilage of the distal ends of the femura was of a pinkish colour and over a large area was ridged "corrugated" and was evidently in process of degeneration preceding erosion.

The patellæ: showed opaque areas and the substance of the cartilage was "tufted" (fluffy) in spots.

The tibiæ: the proximal ends of the tibiæ had definite well-formed ulcerations (scarlet edges and yellow centres).

The hocks: were bulging and the synovial contents of a deep yellow colour. On boiling out, the bones showed exostoses, particularly the oscalcis and astragalus.

The fetlocks: the sesamoid bones were particularly affected by an ostitis and a new bony growth.

Material was taken under the usual precautions from mesenteric glands, heart, liver and the joints.

Microscopical and bacteriological reports were negative. This is in accordance with the view that "the micro-organisms present in some other part of the body do not invade the joints and adjacent tissues but the inflammatory process represents an anaphylactic reaction to the influence of toxin upon these parts." (Hutyra and Marek, 1938. Vol. III, page 480.)

The primary focus, however, was obscure in this case, for careful search failed to reveal it.

OBSERVATIONS ON THE NATURAL FOOD OF THE YOUNG CHICK OF THE DOMESTIC FOWL

By A. BROWNLEE, B.Sc., M.R.C.V.S.
Midlothian.

A RECENT paper on the food of the partridge chick by Ford, Chitty and Middleton (1938) shows that for the first fortnight after hatching the partridge chick under natural conditions feeds principally on animal food and that after this time there is a short transition period during which a switchover to a dietary consisting mainly of vegetable food takes place. The food of young birds, which although when adult may be mainly graminivorous, frugivorous or omnivorous in their food habits, is in practically all cases animal food such as earthworms, slugs and insects (Thomson, 1923; Saunders and Clark, 1927; Pearson, 1936). The food of the young pigeon in early life consists of a secretion from the crop of the parents (Thomson, *loc. cit.*).

Beebe (1937) records having found in the crop of a two weeks old chick of the Jungle Fowl (*Gallus bankiva*) a piece of scarlet earthworm, several small grubs and a piece of grass blade. He believes that insects form an important part of the food of the young of this species. Since the jungle fowl is reputed to be the ancestor of the present-day domestic fowl, a study of the food of its young in their native haunts would be valuable as a guide to the methods which should be adopted for the feeding of the chick under conditions of domestication. Such a study is rendered difficult by the fact

that the geographical distribution of *Gallus bankiva* lies in parts of India and South-Eastern Asia.

As a compromise the author considered that useful information might be obtained by placing domestic broody hens along with newly hatched chickens under conditions in which they could get natural food but would receive no artificial feeding, and that by destroying these chicks at varying intervals after the time of hatching and examining their crop contents, the type of food picked up at different ages could be studied.

Technique adopted for the examination of the crop contents.—The chicks were weighed within an hour after the time of destruction, the crop dissected out and its contents evacuated. The animal matter was separated out from the vegetable, each portion weighed and then stored in alcohol to await identification. In a few cases the vegetable material (seeds and tubers) was air-dried and stored. Where small insects were mixed with large numbers of small seeds or small seeds and insects were embedded in the semi-macerated tissue of soft-bodied animals the separation of the two types of constituents was not quite complete. The numbers of Collembola, Aphidæ and spurrey seeds would be most affected and the figures given for these may be rather lower than the actual. It is not considered that the error in the weights due to this cause would be an important one.

Two series of observations were made:—

Experiment I.—On the 12.5.39, twenty-five day-old, sex-linked cockerels, hatched out in an incubator, were divided into three lots of 8, 8, and 9 respectively and one lot given to each of three broody hens. However, one hen killed two of her brood and injured a third, which was destroyed. The remainder of this lot was given to the other two hens. After the chicks had been a few hours in the broody hens' nests and were adopted, the two hens with the chicks were removed to the experimental habitat (land on a farm in Mid Lothian). The terrain chosen was a piece of waste ground on the bank of a stream. Throughout these experiments this terrain will be referred to as the "West." That part of this bank of which the hens availed themselves had an exposure west, north-west and north. The west part of the bank was partly covered with hawthorn, willow and broom bushes, with a ground growth of grasses, comfrey, queen of the meadow, water avens, etc. The coops were placed in this part. The north part was heavily shaded by trees, mostly elm, and the undergrowth here was more sparse. On the lower levels of this part of the bank *Ranunculus ficaria* had established itself. A small protected coop was provided for each hen. These were shut at night and left open during the day time. Drinking water was placed in or beside each coop.

In this and the following experiment, for the first two days the hens and chicks remained in or close to the coops seeking little food. After this time they searched for food with increasing range, periods of feeding being

interspersed with periods of rest. In addition to receiving food found for them by the hen, the chicks foraged on their own behalf usually with head lowered seeking food on or close to the ground.

It became apparent early in this experiment that the chicks were unable to find sufficient food. One chick destroyed on the 15.5.39 showed an empty crop (hence it is not included in the tables), a piece of grass blade in the proventriculus and a slug and one seed in the gizzard (the seed was not preserved for identification). On the 16.5.39 the two hens were found fighting. Seven chicks disappeared, presumably the work of depredators, and three which were debilitated were destroyed. The crop of each of these three was empty and the gizzard contained only gravel. At this juncture, in addition to what they could pick for themselves the chicks were occasionally hand fed with small slugs and earthworms for two to three days only. No hand feeding was given on the 18.5.39, a day on which a chick was destroyed for examination. Also each unit was removed from the "West" to a cultivated field in which young seeds hay was growing. Part of this field had been in wheat and part in oats during the previous season. This new terrain will be referred to throughout these experiments as the "hayfield." The two coops were placed, widely separated, on a narrow border of waste ground covered with grasses and other plants, adjoining the hayfield. They were removed a short distance daily.

On this cultivated soil the chicks were able to obtain more food than on the "West" (see tables Chick I). By the 21.5.39 predators had reduced the total number of chicks to three, one of which was weakly and was destroyed. Its crop and gizzard were almost empty, hence it is not included in the table. On the 22.5.39 predators removed another chick and on the 23.5.39 the remaining one was destroyed for examination.

The failure of the chicks to maintain themselves on the "West" and the very limited variety of the kinds of food available as indicated by an examination of the crop contents of Chicks I and II show that at this season of the year there was too little suitable food available. This deficiency of food was doubtless accentuated by the rather large broods in the early stages.

Experiment II.—The methods of husbandry and technique were similar to those adopted in Experiment I. On 31.5.39 three broody hens with nine, seven and eight day-old cockerels were placed in the "West," the "hayfield," and a new terrain, the "North," respectively. The "North" was the waste ground of a river bank with a northern exposure. The bank was clothed with large trees, mostly beech and elm with undergrowth of grasses, umbelliferous plants, *Ranunculus ficaria,* etc. Although the coop was placed close to the edge of the river the hen by the fourth day after the commencement of the experiment had learned to climb the bank to get access beyond to a cultivated field on part of which was a crop of young seeds hay, and on part a crop of oats with a nurse crop of grass seed mixture intended for hay the following

TABLE I

Chick No.	Date of Destruction	Habitat	Age in Days	Total Weight	Weight of Animal Matter in Crop	Weight of Vegetable Matter in Crop	Animal : Vegetable Weight Ratio
I	18.5.39	Hayfield	6	—	2.382 gms.	0.798 gms.	2.98 : 1
II	23.5.39	Hayfield	11	—	0.72 gms.	0.75 gms.	0.96 : 1
III	2.6.39	West	2	—	0.045 gms.	nil	—
IV	3.6.39	North	3	—	0.282 gms.	0.50 gms.	0.56 : 1
V	3.6.39	Hayfield	3	—	0.15 gms.	1.80 gms.	0.08 : 1
VI	4.6.39	West	4	1.47 ozs.	0.806 gms.	0.001 gms.	806 : 1
VII	6.6.39	Hayfield	6	1.75 ozs.	2.021 gms.	0.85 gms.	2.38 : 1
VIII	6.6.39	North	6	1.65 ozs.	3.525 gms.	0.665 gms.	5.30 : 1
IX	10.6.39	West	10	1.65 ozs.	0.774 gms.	1.59 gms.	0.49 : 1
X	16.6.39	North	16	3.07 ozs.	7.731 gms.	2.166 gms.	3.57 : 1
XI	21.6.39	North	21	4.28 ozs.	4.887 gms.	7.106 gms.	0.69 : 1
XII	29.6.39	West	29	4.42 ozs.	5.522 gms.	7.422 gms.	0.74 : 1
XIII	6.7.39	North	36	8.35 ozs.	11.533 gms.	15.13 gms.	0.76 : 1

season. The hen and brood spent much of their time in this oats portion but returned each evening to their coop.

Only two chickens were obtained for crop examination from the "hayfield" lot. Instead of returning to its coop in the evenings the hen spent the night in an unknown resting-place. She and her chicks were not seen after the 6.6.39, and it is presumed that a fox had removed them.

The hen on the "West" availed itself of a limited range early, and later a wider one which included the area where *Ranunculus ficaria* was growing. It was never seen to climb the bank to cultivated soil and it returned to its coop each evening.

Results. — The details of the weights of the chicks and the weights and analyses of the crop contents are shown in Tables I and II.

Discussion. — An examination of these results appears to indicate that the respective amounts of animal and vegetable food taken by these chicks was governed principally by availability. The chickens of the "West" lot were unable to obtain appreciable amounts of vegetable matter until they were at least four days old, while those of the "hayfield" and "North" lots were ingesting considerable quantities of grass seeds and *Ranunculus ficaria* tubers respectively by the time they were three days old. It is interesting to compare the crop contents of Chicks V and VII, both of the "hayfield" lot. In Chick V the animal : vegetable matter ratio is 0.08 : 1, whereas in Chick

TABLE II. ANALY

	Chick I	Chick II	Chick
Annelida	2 Earthworms 4 Pieces earthworm	1 Earthworm	
Mollusca	2 Slugs	—	
Crustacea	—	—	
Insecta—			
Thysanura	—	—	
Collembola	—	4 Specimens	
Dermaptera	—	—	
Plecoptera	—	—	
Thysanoptera	—	—	
Hemiptera	—	1 Aphidæ	
Neuroptera	—	—	
Trichoptera	—	—	
Lepidoptera	1 Caterpillar	—	
Coleoptera	1 Click-beetle adult* 1 Carabid? adult*	1 Carabid adult	
Hymenoptera	—	—	
Diptera	—	3 Adults	
Myriapoda	—	—	
Arachnida	—	—	
Cruciferæ	5 Fruits of *Raphanus raphanistrum* (wild radish)	—	
Caryophyllaceæ	—	316 Seeds of *Spergula arvensis* (corn spurrey)	
Ranunculaceæ	—	—	
Leguminosæ	—	—	
Gramineæ	5 Oat grains	8 Oat grains	
Miscellaneous vegetable material	—	—	

* One of these was in the gizzard. Weights are of crop contents only.

OF CROP CONTENTS

Chick IV	Chick V	Chick VI	Chick VII
1 Earthworm	—	—	—
—	—	2 Snails	2 Slugs
—	—	1 Woodlouse	—
1 Specimen	—	—	—
—	23 Specimens	—	10 Specimens
—	—	—	—
—	—	—	—
—	—	—	—
—	6 Aphidæ	16 Aphidæ	23 Aphidæ
—	14 Other Hemiptera	8 Other Hemiptera	10 Other Hemiptera
—	—	—	—
—	—	—	—
—	2 Caterpillars	1 Caterpillar	4 Caterpillars
—	4 Staphylinid adults	4 Click-beetle adults	4 Carabid adults
—	—	—	14 Click-beetle adults
—	—	—	2 Curculionid adults
—	—	—	9 Staphylinid adults
—	—	—	—
8 Adults	5 Adults	56 Adults	6 Adults
—	—	3 Millipedes	—
1 Spider	5 Spiders	4 Spiders	12 Spiders
—	—	—	—
—	—	—	—
17 Tubers of *Ranunculus ficaria* (lesser celandine)	—	—	—
—	—	—	—
—	1835 Immature seeds, almost entirely of *Holcus*, probably *H. lanatus*	—	808 Immature seeds almost entirely of *Holcus*, probably *H. lanatus*.
—	—	1 Piece of bud scale†	1 Small piece of grass blade†

† Not preserved for identification.

TABLE II. ANALYSIS OF

	Chick VIII	Chick IX
Annelida	—	—
Mollusca	4 Snails	4 Slugs
Crustacea	—	—
Insecta—		
Thysanura	—	—
Collembola	3 Specimens	—
Dermaptera	—	—
Plecoptera	—	—
Thysanoptera	1 Specimen	—
Hemiptera	11 Aphidæ 1 Other Hemiptera	13 Aphidæ 1 Other Hemiptera
Neuroptera	1 Adult	—
Trichoptera	—	—
Lepidoptera	60 Caterpillars	2 Caterpillars
Coleoptera	4 Carabid adults 11 Click-beetle adults 21 Curculionid adults 1 Chrysomelid larva 1 Pupa 3 Orchestes larvæ	5 Staphylinid adults 1 Carabid? adult
Hymenoptera	—	—
Diptera	1 Acalyptrate muscid. 163 Adults	20 Adults
Myriapoda	1 Millipede	1 Millipede
Arachnida	2 Spiders	4 Spiders
Cruciferæ	—	—
Caryophyllaceæ	—	—
Ranunculaceæ	22 Tubers of *Ranunculus ficaria*	62 Tubers of *Ranunculus ficaria*
Leguminosæ	5 Seeds of clover and wild vetch	—
Gramineæ	13 *Holcus lanatus* seeds	—
Miscellaneous vegetable material	—	—

CROP CONTENTS—Continued

Chick X	Chick XI	Chick XII	Chick XIII
		21 Pieces of earthworm	8 Pieces of earthworm
2 Small snails	4 Slugs	4 Small slugs	11 Slugs
1 Slug	3 Eggs	2 Eggs	1 Small snail
		1 Woodlouse	
5 Specimens			
		1 Earwig	
		3 Adults	
45 Aphidæ	4 Aphidæ	22 Aphidæ	9 Aphidæ
21 Other Hemiptera	1 Other Hemiptera	10 Other Hemiptera	9 Other Hemiptera
1 Caddis fly	4 Caddis flies	1 Caddis fly	1 Caddis fly
15 Larvæ	7 Caterpillars	1 Adult (moth)	1 Caterpillar
1 Pupa	1 Adult	8 Caterpillars	
2 Tineid larvæ?		7 Pupæ	
		7 Cocoons	
6 Silphid larvæ	3 Curculionid adults	4 Staphylinid adults	3 Curculionid adults
2 Chrysomelid larvæ	8 Staphylinid adults	10 Chrysomelid adults	4 Cicindellid adults
110 Click-beetle adults	2 Cicindellid adults	4 Carabid adults	49 Carabid adults
3 Curculionid adults	28 Click-beetle adults	3 Click-beetle adults	2 Carabid larvæ
6 Staphylinid adults	27 Carabid adults	7 Curculionid adults	21 Staphylinid adults
1 Carabid larva	3 Carabid larvæ		19 Chick-beetle adults
48 Carabid adults			1 Silphid adult
3 Cicindellid adults			
89 Saw-fly larvæ	10 Saw-fly larvæ	7 Adults	1 Adult
2 Adults	2 Saw-flies		
	1 Larva (Apocrita)		
1 Leptis scolopacea adult	39 Adults	1 Tipulid adult	30 Adults
100 Other adults	3 Larvæ	1 Syrphid adult	
1 Calyptrate muscid maggot		1 Muscid adult	
		3 Stratiomyid adults	
		75 Other adults	
2 Millipedes	1 Millipede	3 Millipedes	1 Millipede
6 Spiders			4 Spiders
			6 Red mites (Acarina)
			354 Fruit capsules (containing seed) of *Spergula arvensis*
52 Tubers of *Ranunculus ficaria*	213 Tubers of *Ranunculus ficaria*	261 Tubers of *Ranunculus ficaria*	49 Tubers of *Ranunculus ficaria*
14 Clover and wild vetch seeds	12 Clover seeds		
1 Husk of oat	64 Seeds of Festuca ovina		
648 Grass seeds including Holcus, Poa, Festuca and Bromus			
	1 Small piece of moss	1 Small green shoot†	

† Not preserved for identification.

VII it is 2.38 : 1. At this time there occurred a very warm spell of weather which presumably had rendered conditions favourable for the appearance of many forms of insect life between these two dates. With the increase in animal food available the amount of vegetable material consumed was decreased.

We notice also that the type of insects present in these crops varied with the habitat, e.g., there were many more beetles in the crops of the " North " lot, which had access to a cultivated field, than in those of the " West " lot ranging on waste ground only. On one occasion a hen was noticed to examine critically an insect which had alighted and after inspection she moved off without attempting to catch it, so that some selection appears to be made.

The type of vegetable food is also largely determined by availability. Chicks I and II both ingested oat grains and Chick II took also a large number of spurrey seeds; for Chicks V and VII grass seeds were available and for the " North " lot tubers, grass and leguminous seeds with fruit capsules of spurrey later. In the " West " lot crops, tubers were practically the only vegetable food found.

Although one hen was several times observed to partake greedily of clover leaves, the chicks did not do so even when, on occasion, the hen would call on them to share. Also on examination of the crop and gizzard contents green grass blades or other green leaves were very rarely found. This lack of desire for green leaves is peculiar when one considers how the adult fowl takes these freely. The stage of development at which the chick under these conditions would have commenced to eat green leaves is not indicated, as the oldest chick (36 days old) had not begun to partake of this type of material by this time.

On examining the crop and gizzard contents it was found repeatedly that while the crop might contain much animal food very little of such material was recognisable in the gizzard. For example, the gizzard contents of Chick VII were found to consist almost entirely of grass seeds and their remains, and in the case of Chick IV the gizzard contained 53 tubers of *R. ficaria* in process of digestion, and only a little other debris. This vegetable material thus appeared to be much more resistant than animal matter to the action of the digestive juices and the grinding of the gizzard; and its digestion was doubtless a severe task for the as yet " untrained " organs of the alimentary tract. The presence of this vegetable material held up in the gizzard would also tend to slow down the process of digestion, rendering the chicken incapable of dealing with so much food as it would have done had the food been composed entirely of easily digested materials.

Under the conditions of these experiments there was undoubtedly more vegetable food available than there would have been had the birds been native to these habitats, in which case the struggle for food during the winter period of scarcity would have ensured that most suitable, accessible vegetable food

would have been removed before the time of arrival of the chicks. It is thus probable that the food of the young chicken under natural conditions would consist to a greater extent of animal matter than in these experiments, but to what extent and for how long these experiments do not show. Certainly there is no indication that during the first five weeks there is any switch-over from animal to vegetable food such as occurs in the case of the partridge chick between two and three weeks of age. Nor do these experiments show that these chicks even during the first fortnight preferred animal food to such an extent as does the newly hatched partridge.

It could not be said that these chicks, even during the second experimental period when food was more abundant, throve well. Although active, they looked rather thin and a few chicks showed soiling of the feathers beneath the vent. The type of food may not have been suitable. The hen had not the choosing of its breeding grounds and its desire to return to its coop each evening would limit the feeding range. These factors, coupled with the terrain being new and unexplored, would weigh against the optimal development of the young chicks. The weights of the chicks, which were recorded, are shown in Table I. The numbers are too few to merit discussion.

Out of 46 chicks only 14 were actually obtained for the examination of crop contents. Four were destroyed in the first experiment as they were debilitated. The "hayfield" lot of the second experiment were considered to have been removed by a fox. The chicks unaccounted for were presumably removed by smaller predators. Magpies and carrion crows were seen repeatedly to be on the watch. The chicks were white in colour and this, along with the lessened activity of the hens due to domestication, would give the predators added opportunity. It is important that rapid growth of the young avian be ensured as this lessens the period of comparative helplessness. As pointed out in the introduction, most birds feed their young on animal food and the well-known rapid development of young birds is evidence of the growth-promoting powers of such a dietary.

Animal food in early life is beneficial also in that, since it is then that the young comes into first contact with its enzootic diseases, the alimentary tract is not being taxed with comparatively indigestible food at a time when the body generally is resisting the first onslaught of these diseases and acquiring a degree of immunity. The great handicap to the young mammalian if deprived of an adequate supply of milk is more generally recognised than is a corresponding deficiency of animal food to the young avian.

Much more experimental work would be required before the findings of these experiments could be applied commercially. It is apparent that the range of food which the young chick will eat is wide, but what constitutes optimal conditions of feeding is not here elucidated. The present-day feeding of mixtures containing a high proportion of cereal products which are probably at least as difficult of digestion by the young chick as the vegetable materials

consumed in the above experiments is likely to throw a strain on the organs of digestion at a critical period. The high incidence of diseases of the alimentary tract in the young domestic chick is an indication that the present-day methods of feeding are far from optimal.

Summary.

1. The analysis of the contents of the crops of domestic fowl chicks kept under "natural" conditions and destroyed for examination at ages varying from 2 days to 36 days showed that under the conditions of the experiments the food consisted of a mixture of animal and vegetable material.

2. The type of food picked up by these chickens appears to be governed largely by availability.

3. Grass blades and other green leaves were very rarely eaten by the chicks up to the time of the conclusion of the experiment.

4. The animal food consumed was more easily digested than the vegetable.

5. These findings are discussed.

Acknowledgments.

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Clinical Articles

VERONAL AS A NARCOTIC

By G. MAYALL, M.R.C.V.S.
Bolton.

A NERVOUS, excitable fox terrier dog, two years old, which was a nuisance by his frequent and unnecessary barking, was given a dose of 15 grains of veronal in the evening by his owner. As he was fast asleep next day and

breathing quickly his owner brought him in to see what could be done as he looked like passing out. He was in a deep sleep when examined, pulse was fairly good and he was put near a warm fire and watched. Nothing appearing in any list of antidotes as to veronal poisoning, and knowing that dogs may sleep for two days after doses of veronal, it was decided to adopt a waiting policy. He slept all night after his entry alongside hot bottles.

On the following morning he was still asleep, pulse was regular and perceptible, but extremities rather cold. He was unable to support his head, but showed some consciousness when slapped and his ears flipped. He soon, however, relapsed into sound sleep again. Late at night, 11 p.m., he was still asleep and pulse slowed and breathing quickened.

No antidotal treatment being discovered, one was left to one's own devices and a start was made by giving half a teaspoonful of strong coffee and a hypodermic injection of 15 minims of oil of camphor 1 in 5. He responded slightly to this procedure and allowed his head to be raised and opened his eyes. A warm bottle was put under his neck and jaw to keep his head off the floor and allow free breathing.

In half an hour a little whisky, sugar and warm water was given and also 30 minims of sal volatile in water, which seemed to be followed by the best show of life up to the present.

It did not, however, seem safe to leave him so, and in a further half-hour two amyl nitrite capsules were broken in front of his nose and the vapour inhaled by him. This made him raise his head without assistance and thereupon he drank quarter of a pint of cold milk from a bowl.

It was now deemed safe to leave him and he was put comfortably on a cushion propped up on his chest before a warm fire.

Next morning, the third day, he drank some more milk, was tottery on his legs, but managed to walk 100 yards. From this time, after taking plenty of steak and cow-heel soup, he gradually reached his former barking propensity, but on the whole seems rather quieter than usual.

The human dose of veronal is given as 5 to 10 grains. German authors state 3 to 30 grains (probably according to size and weight of the dog). Milks states that veronal is not used in veterinary medicine.

Georg Müller, in his "Pharmacology for Veterinary Surgeons" (trans. title), states: "Large doses cause gastric symptoms, albuminuria and cramp and may kill by respiratory paralysis." Fröhner writes: "Jakob recommends veronal sleep for destroying dogs and gives 30 to 120 grains for this purpose."

Abstracts

NUTRITIONAL CONDITION OF LAMBS AND THEIR SUSCEPTIBILITY TO ARTIFICIAL INSEMINATION *

By A. H. H. FRASER and W. THOMSON
Rowett Research Institute, Aberdeen,
and
D. ROBERTSON and W. GEORGE
North of Scotland College of Agriculture.

INTRODUCTION.—The importance of the nutritional state of the host on its susceptibility to parasitic helminths is now generally recognised. We have previously reported an experiment on sheep[1] which supported the results of earlier pioneer work by Foster and Cort with dogs[2]. Our experiment on sheep, however, was open to certain justifiable criticisms. The procedure therein adopted was to produce a wide difference in bodily condition, due to nutrition alone, in parasite-free lambs; to graze the lambs on heavily worm-infested pasture for a period; to slaughter the lambs at the end of the grazing period, and to count certain species of nematodes contained in their fourth stomachs at the time of slaughter. Using this method it was found that the average number of *Hæmonchus* contained in the stomachs of 16 lambs well fed after the grazing period was 31; whereas the corresponding number for an equal number of lambs poorly fed after the grazing period was 103.[1] The conclusion drawn was that. owing to their relatively poor nutrition before being exposed to infection, the poorly fed lambs had a greater susceptibility to infestation with *Hæmonchus,* and consequently contained a greater number at slaughter.

Now it is a matter of common observation that the daily grazing period of lean sheep is longer than that of fat sheep. It might therefore be argued that the result we obtained was due simply to the fact that our poorly fed group of lambs when put out to graze worm-infested pasture ate more grass (even although special precautions were adopted to avoid this source of error), and consequently ingested more infective nematode larvæ than our well-fed group of lambs. In short, it might be argued that the statistically

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significant difference in worm-burden we obtained was due to a difference in the dosage of the parasite rather than to a difference in the susceptibility of the host. Such argument is to a certain extent supported by a later observation made by us that when parasite-free lambs are put out to graze worm-infested pasture, the number of worms found in them at slaughter is rather closely correlated with the live-weight gains made by them while grazing[3].

It therefore appeared necessary to repeat our previous experiment, but on this occasion avoiding the possible fallacies due to grazing, by keeping the lambs throughout the experiment on a quantitatively controlled and worm-free diet, securing an equal chance of infestation by artificially infesting each individual lamb with a known dosage of worms.

Methods

Animals.—Worm-free lambs were obtained as follows. The lambs were allowed to have their first drink from their dams, and thereafter kept separate from all other sheep in concrete pens bedded with sawdust. The lambs were fed cows' milk and concentrates, without fodder of any kind. Repeated examination of fæces showed that the lambs remained parasite-free.

Feeding.—When between 2 and 3 months of age the lambs were divided into two groups of 20. From then (18. v. 37) onwards until slaughter (8. ix. 37), a period of 113 days, one group (hereafter referred to as the "well-fed" group) was fed a full production ration, while the other group (hereafter referred to as the "ill-fed" group) was fed a ration sufficient to maintain life but not for normal growth.

The ration of the well-fed group was:

A. *Concentrates*

	Per cent.		*Per cent.*
Earthnut cake	4.0	Sharps	16.0
White fish-meal	4.0	Pea- or lentil-meal ...	19.0
Ex. soya-bean meal ...	6.0	Rice-meal	10.0
Linseed-cake meal ...	6.0	Ground chalk	3.0
Locust-bean meal ...	12.5	Salt	0.6
Ground maize	16.25	Cod-liver oil	0.9

Fed *ad lib.*

B. Cows' whole milk ... 4-4½ lb. daily.

The ration of the ill-fed group was:

A.

		Per cent.
Crushed oats	1 part	Chalk 2.0
Bran (medium)	1 part	Salt 1.0
Cooked maize	1 part	Cod-liver oil 0.5

B.

No milk.

These rations were modified later in the experiment in that separated milk was substituted for whole milk in the ration of the well-fed group on grounds of expense; and a certain amount of separated milk was fed to the ill-fed group because some lambs in it were becoming too weak.

Administration of infective larvæ.—In an experiment of this kind the two essentials for an absolutely decisive experiment are lambs initially

parasite-free, which we were successful in securing, and a pure culture of large numbers of infective larvæ of one species of parasitic nematode which, unfortunately, in the present stage of helminthological technique, is difficult to obtain. We were therefore forced to use a mixed culture of infective larvæ secured from incubated sheep fæces as our infective agent. We endeavoured, however, to ensure that each lamb dosed received an approximately equal number of infective larvæ. It is necessary to describe the technique adopted in some detail. We are of the opinion that in view of the number of sheep used in the experiment and of the wide difference in worm-infestation between the two groups ultimately established, any minor errors produced by our method of dosage are unimportant.

The following method was used:

The recta of newly killed lambs were collected daily from the slaughter-house. The fæces were emptied on to a tray, moistened slightly if necessary, and crumbled lightly with a glass rod. They were then transferred to a Kilner jar which was charged up to one-third of its capacity. The rubber band at the top was removed, the glass lid placed on, and the screw-cap loosely fitted. It is important that the cultures should receive plenty of air. Diarrhœic fæces were not used. The jars were kept in the dark at 25-27 deg. C. It was found that cultures kept in an oven were often poor and that the most satisfactory results were obtained using a large wooden box fitted with a darkened electric bulb. This method allowed a greater circulation of air. Every few days a few drops of water were added to the cultures and the sides of the jar moistened with a camel-hair brush.

The unimportant *Strongyloides* spp. appear in cultures in 2-3 days, *Hæmonchus, Ostertagia, Trichostrongylus* in 3-5 days, *Chabertia* in 6-7 days, and *Nematodirus* in 14 days. By keeping the cultures from 7-14 days, depending on the time of collection of the fæces, all the important species should have reached the infective stage. On the day before the lambs were dosed, the cultures were exposed to diffused sunlight. It has been recommended[4] that half an hour in the light is sufficient, but it was found that greater numbers were recovered by leaving the cultures overnight.

The doses were prepared by the following method. Approximately 40 lambs were to be dosed, each being given 20 c.c. of the "infective fluid," i.e., 800 c.c. had to be prepared for each dosage. Using lukewarm water the larvæ were washed off the sides of the jar and transferred to a graduated cylinder. Two or three washings were required to remove all the larvæ. Care was taken to prevent too much fæcal contamination. The washings were made up accurately to 800 c.c. Using a fine-bored pipette, 0.1 c.c. of this mixture was drawn off and transferred to a small glass staining-well. Under a low-power dissecting microscope it was possible to distinguish between the unimportant *Strongyloides* spp., the saprophytic free-living forms, and the other parasitic infective larvæ (Note—for brevity the larvæ of

Hæmonchus, Ostertagia, etc., will be referred to as "parasitic larvæ"). It was, however, not possible by this method to estimate the numbers of the different species of parasitic larvæ. Counts of the total number of parasitic larvæ were made. Five or six samples were drawn off and the average count taken. In this way the approximate numbers of parasitic larvæ in each 20 c.c. dose could be estimated.

A 20 c.c. pipette was used to measure off each dose, which was then transferred to a small glass tube fitted with a cork. The mixture was stirred thoroughly during this operation to ensure a uniform sample. It is important that the doses be prepared almost immediately before the treatment of the lambs, as it was found that the larvæ kept in tightly stoppered tubes for a few hours became lethargic.

The lambs received their doses by stomach-tube.

The following is the summary of the doses administered to each individual lamb:

Date	*No. of parasitic larvæ*
June 18	1,500
June 30	2,200
July 14	6,000
July 28	4,500
August 11	6,000
August 25	8,500
Total	28,700

The lambs were slaughtered on September 8, 1937. The worms were isolated from the ingesta of the fourth stomach and counted by the method previously described by us[5].

Results

Mortality.—During the experiment 4 lambs died. Three of these were in the ill-fed and 1 in the well-fed group. The cause of death requires a short discussion. It is improbable that the worm-infestation was responsible. The casualty in the well-fed group occurred before the first infestation was performed. The three casualties in the ill-fed group occurred after infestation. Indeed, infestation was found to have an ill-effect on all lambs in the ill-fed group, producing intestinal disturbance and loss of appetite. Nevertheless, this pathogenic effect of infestation cannot be attributed to the infective larvæ themselves, since it was found that the administration of the culture heated to 60 deg. C. to kill the larvæ, or of the culture filtered to remove the worms, had a precisely similar pathogenic effect when administered to a control group of worm-free lambs. It is probable that the worm-culture contained toxins, and that these toxins were responsible for the pathogenic effects observed.

Weight.—The great difference in the plane of nutrition between the

two groups naturally resulted in a correspondingly wide difference in weight and condition at the close of the experiment. Thus:

	Well-fed group	*Ill-fed group*
Average live-weight (in lb.) at the beginning of the experiment (18. v. 37)	32.3	31.5
Average live-weight at end of the experiment (8. ix. 37)	100.5	41.0
Average weight of carcass	48.9	17.3

Worm-burden.—There was an equally great difference in the number of worms recovered from the fourth stomachs of the lambs on slaughter.

Count of Worms present in Fourth Stomach of Lambs.

ILL-FED GROUP

No. of lamb	*Ostertagia sp.*	*Haemonchus contortus*	*Trichos. axei.*
1	260	80	Nil
2	200	40	,,
3	120	40	,,
4	7	40	,,
5	140	140	,,
6	140	40	,,
7	180	60	,,
8	160	20	,,
9	240	40	,,
10	320	100	,,
11	260	220	,,
12	600	80	,,
13	160	80	,,
14	340	160	,,
15	240	80	,,
16	260	40	,,
17	250	104	30
18	225	68	15
19	250	101	Nil
	4,352	1,533	45
Average	229	31	3

WELL-FED GROUP

No. of lamb	*Ostertagia sp.*	*Haemonchus contortus*	*Trichos. axei.*
1	9	1	Nil
2	18	Nil	,,
3	23	1	,,
4	10	2	,,
5	30	Nil	,,
6	72	6	,,
7	1	3	,,
8	4	1	,,
9	5	6	,,
10	2	Nil	,,
11	14	1	,,
12	Nil	2	,,
13	8	5	,,
14	6	Nil	,,
15	2	3	,,
16	6	Nil	,,
17	2	2	,,
18	4	Nil	,,
19	3	Nil	,,
	219	33	
Average	11	2	

Discussion

The results of this experiment show the profound effect of nutrition on the resistance of lambs to an artificial worm-infestation. Every lamb in both groups received approximately the same number of infective worm larvæ. The only known difference between the two groups of lambs was that one was well-fed, the other ill-fed. At the time of slaughter the average number of worms recovered from the stomachs of the well-fed lambs was: *Ostertagia* 11, *Hæmonchus* 2, *Trichostrongylus* 0. In the stomachs of the ill-fed lambs the corresponding figures were: *Ostertagia* 229, *Hæmonchus* 81, *Trichostrongylus* 3. Such a clear-cut result requires no statistical analysis.

The infestation produced in both groups was a light one and almost certainly not pathogenic. Nevertheless, the effect of the nutrition of the lamb in resisting infestation is quite clear.

In considering this result the more direct effect of food in relation to intestinal parasites must be kept in mind. The relation is possibly of a different nature from that obtaining in a bacterial or virus invasion of a host. It is evident that the conditions localised to the intestines may have an important influence on the host's resistance to intestinal parasites. Of probable importance is the amount of food contained in the intestine—what may be roughly called the bulk factor. It is conceivable that the chances of an infective helminth larva obtaining an attachment to the intestinal mucosa are increased by relative emptiness and lessened motility of the host's gut. In the experiment described the bulk of food consumed by the well-fed group was more than double that consumed by the ill-fed group, and this difference in the bulk of the food eaten may conceivably have influenced the degree of worm-infestation artificially established. On the other hand, the increased resistance to worm-infestation as a result of good feeding may have been an expression of an increased general vitality of the host. The question, one of considerable interest, is suitable for experimental investigation but cannot be clarified by the results of the experiment described.

Summary

Two groups of 20 parasite-free lambs were artificially infested with an approximately equal number of infective nematode larvæ. The only known difference between the two groups was that one group was well-fed, the other ill-fed. On the lambs being slaughtered and the contents of their fourth stomachs examined, it was found that the ill-fed lambs had retained a much greater number of larvæ than those well-fed. The average count for the ill-fed group was: *Ostertagia* 229, *Hæmonchus* 81, *Trichos. axei* 0. The corresponding figures for the well-fed group were: *Ostertagia* 11, *Hæmonchus* 2, *Trichos axei* 0.

Acknowledgment.—We are indebted to the Agricultural Research Council for financial support of this investigation.

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FRACTURES *

By BERNARD F. TRUM

Captain, Veterinary Corps.

THE Surgeon General's file furnishes us with the most complete information concerning fractures of the leg bones of horses that can be found in this country. It is not generally known what percentage of fracture cases heal. It is the purpose of this paper to give this interesting information which we hope will be a useful aid towards a more successful and accurate prognosis. The report includes recorded cases of the years 1928 to 1936, excepting 1932.

In eight years there were 797 cases of fracture of bones of the legs reported to the Surgeon General's Office and 149 or 18.7 per cent. were returned to duty. In general this means about one out of every five. Of the simple fractures 30 per cent. were returned to duty, whereas 15 per cent. of the compound fractures and only 5 per cent. of the comminuted fractures healed satisfactorily. There were twice as many compound as comminuted fractures occurring and their total did not equal the number of simple fractures. Doubtless a certain number of those destroyed might have recovered but the uncertainty of the outcome and cost of treatment made destruction the more economical procedure.

The average number of days' treatment, computed only for cases returned

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* *Veterinary Bulletin*, April, 1939, for the Veterinary Corps Medical Dept., U.S. Army.

to duty, was 49.5 per cent.; this is two and one-half times greater than the average number of days lost per admission for all causes as reported in the Surgeon General's Annual Report for 1937.

Over 34 per cent. of the cases with fractures above the elbow and stifle joints were returned to duty. This is comparatively contrary to human surgery where the greatest difficulties are met in these fractures. The anatomical difference of the horse accounts for this. Rarely is there a complete fracture above these joints, the notable exception being fractures of the wing of the ilium which usually heal with a deformity but no resultant disability. The heavy musculature covering the upper leg bones offers greater protection against initial injury.

In comparing the healing rate of the hind and fore legs we find that as far as the long bones are concerned (femur, tibia and metatarsal and the humerus, radius and metacarpal) perfect healing occurs equally as slowly in one as in the other. There was 7.6 per cent. of horses returned to duty after breaking one of these bones in the hind leg and 7.8 per cent. after fracturing one of these bones in the fore leg.

The tibia is fractured most frequently and the possibility of satisfactory healing is slight. There were 174 cases, or about 22 per cent. of all fracture cases, and only 3 cases were returned to duty. A fracture of the radius is also very serious, since there were 109 fractures of this bone and only four recovered satisfactorily.

The longest period of convalescence is experienced following fractures of the metacarpal and the metatarsal bones and in such cases it is so long that it may be an economic loss to undertake treatment in common horses even with a very favourable prognosis. One comminuted fracture of the metatarsal was treated for 125 days and 3 simple fractures of the metacarpal lost an average of 107 days. Out of 114 cases only 9 were returned to duty.

The patella and the second phalanx have not been successfully treated during the period covered by this paper. One reason for not attempting to mend these bones is that the respective joints are always involved. Open reduction without absolute asepsis throughout the course of repair would invariably lead to an infection that would be as bad as the fracture.

Horsemen may be surprised to know that the first phalanx is fractured 25 times more frequently than the second. This seems to be completely out of proportion to the usual observation and common experience. No adequate explanation can be suggested.

Fractures of the ilium respond very well to treatment, as 78 out of 122 cases, or 64 per cent., were returned to duty. Here we have the highest percentage of recoveries in all fractures of the bones considered.

Under the headings of Fracture—delayed healing, faulty union, or exuberant growth there have been no entries made during the entire period from 1928 to 1936. There were two cases of Fracture—faulty union entered

on the sick and wounded register during this period. One of these cases was returned to duty after 51 days of treatment. The other case died or was destroyed. From these notations we conclude that discrimination was shown in the selection of cases to be treated or that these causes were shown either under complications or other causes of admission such as exostosis.

The economic consideration can hardly be dissociated from the prognosis in determining the handling of each case. Young foals with low maintenance debits and their active tendency to heal deserve more of a sporting chance to live than do old horses. Slow working draft horses can compensate in their gait and thus tolerate an unfortunate callous formation and still do their work efficiently, whereas the running, trotting, or saddle horse would be useless. Mares and stallions are naturally useful for breeding even with an impediment in mobility. In each case the animal's worth is not above that price which would guarantee a suitable replacement. Thus, if the average price of a service animal is $165 it is not logical to spend more than that to return him to duty.

Animals worth considerably more than $165 may break their legs; however, such animals are often insured. For this reason valuable horses are frequently destroyed without hesitation when they break a leg. In this way their suffering is terminated and their owner compensated, whereas if the animal is kept he will in all probability be an economic loss. As a matter of comparison the following average prices are quoted from reports of the largest thoroughbred sales in the country, as printed in the *Lexington Leader*. The average price paid at the Saratoga sales (yearlings) was $2484.23. The average price at the Lexington sales (all ages and sexes) was $651.14. These were the prices in 1936 and through personal correspondence with the largest livestock insurance companies in America I was informed that one company paid an average of $3193.75 on claims for horses that were destroyed because of fractures. Another company manager says that at least 25 per cent. of their livestock claims are for fracture of the small bones of the legs of horses.

Many horses recover from fractures of the leg bones. The means are known and available for treating any case of fracture in the horse but it is unconditionally recommended that all horses suffering from fracture injuries that would lead to primary or secondary amputation in human surgery be immediately destroyed to terminate suffering. These injuries include such as the severance of major blood vessels or nerves, grossly comminuted or compound fractures and serious infections.

All other cases can be treated and cured. However, the animal's future economic usefulness must always be considered. A cured animal may not be a useful one, as a satisfactory recovery depends on the nature of the fracture, the healing process, and the type of duty to which the animal will later be assigned. Only the veterinarian is qualified by special training to advise efficiently concerning fractures in equines.

THE CLASSIFICATION OF THE STREPTOCOCCI OF BOVINE MASTITIS *

By R. B. LITTLE and F. C. MINETT

Summary

THE purpose of this note is to call the attention of workers who are interested in a project initiated by one of us (R. B. L.).

The necessity for trying to get some orderly arrangement of the streptococci which may be associated with bovine mastitis has long been obvious. Not only is this so on the grounds of bacteriological nomenclature, but, unless investigators in different parts of the world use the same designations, it is difficult or impossible to make those comparisons which are essential for a proper understanding of the subject and in consequence scientific progress is impeded. To give an example. The term *Streptococcus mastitidis* has been used in the past for more than one kind of mastitis streptococcus, whereas in fact it is now known that there are several kinds of streptococci recognised by experienced workers as capable of causing different forms of the disease. Moreover, only one of these forms is known to spread easily in a herd. The subject of classification, therefore, has a clear relation to preventive and clinical veterinary medicine.

Briefly, we have decided to ask those who are studying mastitis to communicate with us. Persons resident in the American continent and Japan should write to Dr. Little, while those in Europe and the British Empire are requested to get into touch with Dr. Minett. Persons who are interested would then be requested to re-examine their cultures (1) by means of a group B standard serum which would be issued (2) by certain relatively simple cultural and biochemical methods. Mimeographed copies of suggested methods for carrying out these tests and forms for recording the results would be sent out at the same time, to be returned as soon as possible to Princeton or to Camden Town, as the case may be. Cultures giving "atypical" reactions should be sent for re-examination to one or other of these centres. Type strains would be issued on request for purposes of comparison. Later on the results of the inquiry would be circulated to all concerned and then, if the majority of workers agreed, they could be published in summary form, with particular reference to "atypical" strains.

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* *Skandinavisk Veterinärtidskrift*, May, 1939.

Appreciation

AN APPRECIATION OF THE LATE WILLIAM WILLIS

THERE are many veterinary surgeons who treasure the memory of that remarkable man, William Willis. Of a gentle, retiring nature, Willis was a man with whom it was good to come in contact, for here was a man who was a deep thinker, possessed of a great brain, and in whose heart there was no guile. He was kindness personified. In appearance he was a typical Victorian—with his wonderful waistcoat, and old-fashioned cut of his clothes, one might easily visualise him stepping straight out of the pages of a Dickens book. A Northerner, he made London his home. He loved London, and Londoners loved him. He was born on October 13, 1862, at Sunderland. His father was a blacksmith and a "horse doctor." As was usual in those days, he passed through a period of work in the forge, and thereby laid the foundations of his subsequent skill which was so manifest when dealing with the foot of a horse. His uncle was a qualified veterinary surgeon, and after a period of pupilage with him he proceeded to the Royal Veterinary College. He was a brilliant student, and he passed his final examinations six months before he was of the legal age to receive his diploma, which was marked April 2, 1884.

Willis's interest was in horses, and most of his life was spent in charge of big studs. He worked for many years with London bus companies, for the London & North Western Railway, and also for the London County Council. He was always prepared to lend a hand to any colleague, and it may be truly said of him that he was a veterinary surgeons' "Vet." What higher tribute could be paid to his professional skill? Forty years ago he forecast a great future for endocrinology. An expert surgeon, he was a clinician who left no stone unturned to reach a correct diagnosis in life, and to check up by means of visits to the slaughter-house. His post-mortems, many of which I have attended as his guest, were models of technique, and most thorough. They often lasted for many hours, and he was familiarly known in the knackers' yards as "The Searcher."

I have known of many occasions on which he has purchased a horse in order that he might make a post-mortem in order to arrive at the truth.

He was an expert on neurectomy operations, and it is doubtful if any man has performed more median operations. I well remember when discussing these operations with him that he stated that at one time he had

Wm. Willis.

See page 416.

200 cases under observation at the same time. He also said that, having done the operation for the alleviation of lameness in all varieties of cases, he was of the opinion that there were few contra-indications to its employment.

He collaborated with Sir Frank Collier in work on dental and periodontal disease, and the odontological museum, at the Royal College of Surgeons, possesses many unique specimens as a result of his work. He published papers in the *Lancet* and in the *Veterinary Record* which achieved the distinction of being translated into several foreign languages, and he was often visited by Continental colleagues.

In his private life he was gentle and unassuming. During his last three and a half years of retirement, when he was in gradually declining health, he was unfailingly patient and good-tempered. Towards the end his memory failed, and his speech became almost incoherent, but one thing remained clear: it was his work, and he had many talks with his medical attendant on medical subjects. On these matters he was lucid to the end.

Although it is now a few months since William Willis passed on, I feel that it is a duty to place on record some little tribute to his memory and to his brilliant and lovable character. Through the kindness of his daughter, Mrs. Jessie Bray, I have now been able to procure a copy of the only photograph she possesses of her father. It was one of the usual seaside snaps.

He died on April 5, 1939, and was 76 years of age.

Correspondence

ANOTHER CASE FOR DIAGNOSIS

To the Editor, THE VETERINARY JOURNAL.

UNDER the heading of "A Case for Diagnosis" in THE VETERINARY JOURNAL for July, 1939, a practitioner describes the peculiar behaviour of a thoroughbred gelding and asks if any veterinary surgeon can throw a light upon it.

"When horse is bridled and taken out of the loose box he starts shaking his head, throwing his head from side to side and up and down to the danger of his rider."

For several years I owned and rode a three parts thoroughbred hunter mare that often, but by no means always, behaved in a similar way. For days or weeks at a time the mare would behave as described above in a more or less

violent way every time I mounted her. At other times weeks and even months might elapse without the symptoms being shown.

She was more apt to have the spasms when in hard training than when "let down" in condition for gentle exercise during the summer months. I dare not turn her out to grass because when she first came up and was ridden she was almost unmanageable by reason of the spasms. Evidently there was an acute hyperæsthesia which, in my opinion, caused a sort of epilepsy when the animal became excited. Mr. Cane reports that changing the bridle or bits made no difference to his case.

The sort of bit made no difference to my mare, but I found that the strange behaviour could be avoided to a considerable extent by tying down the browband on to the cheek strap of the bridle so that no pressure came upon the base of the ear.

Conversely, one could sometimes bring on an attack artificially by adjusting the browband so that it would pinch the base of the ear. In all other respects the animal was always in perfect health for years until she was sent to stud at nine, consequently I concluded that there could be no brain or bony cranial lesion.

My mare never showed the symptoms when tired towards the end of a day's hunting or the next day after very hard work: the hyperæsthesia was always most evident, as one would expect, when she was fresh and otherwise excitable.

WAKEFIELD RAINEY.

Bloemfontein, O.F.S.,
South Africa.

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